

Worksheet for Assigned Radiation Monitor Unit 1 Self Study

1. Which of the following groups regulates Jefferson Lab with respect to radiation protection?
 - a. NCRP
 - b. DOE
 - c. NRC
 - d. NRRPT

2. The NCRP (National Council on Radiation Protection) has regulatory authority over all U.S. entities who are involved in radiation producing activities.

True
False

3. Why does Jefferson Lab have its own administrative dose control level which is more restrictive than the DOE imposed limit? _____

4. Why is the extremity dose limit higher than the whole body dose limit? _____

5. The ARM's chain of command is through _____ whenever performing radiological functions.

6. The curie applies to measuring what quantity?
 - a. The dose rate at a specific distance from a radioactive source.
 - b. The quality factor.
 - c. Specific ionization.
 - d. The number of radioactive atoms decaying in a given time.

7. A swipe reads 700 cpm above background. Give the activity in dpm.

8. Dose equivalent (rem) is used to account for our exposure to radiation because absorbed dose (rad) does not take into account _____.

9. Alpha particles produce _____ (more/less) ionization per unit distance traveled in material than gamma rays. Therefore the range of alphas is _____ than gamma. This characteristic leads to a _____ (higher/lower) quality factor for alpha.
10. The quality factor for neutron radiation of energy $\sim 1\text{MeV}$ is _____.
11. A person receives an *absorbed dose* of: 0.1 rad of gamma radiation, and 0.5 rad from *thermal* neutrons. What is the total *dose equivalent*? _____.
12. External beta radiation is primarily a hazard to.
- a. lungs
 - b. skin
 - c. whole body
 - d. embryo
13. Bremsstrahlung refers to _____ radiation produced by the interaction of _____ with matter.
14. Rank the following interactions of gamma radiation in terms of the energy ranges in which they occur most commonly. (1-4, lowest to highest energy)
- Pair production _____
- Photoelectric effect _____
- Compton scattering _____
- Photo-nuclear reactions _____
15. All ionizing radiations impart kinetic energy to matter by liberating charged particles (ions). In elastic neutron scattering events, what type of charged particles are liberated (scattered)?

Worksheet for Assigned Radiation Monitor Unit 2 Self Study

1. Prompt radiation is the term given to radiation that is produced when: _____

2. The electron interaction that initiates most prompt radiation production is : _____
3. Rank the following targets in their photon production capability at energies >20 MeV? (1= highest)
 - a. beryllium
 - b. copper
 - c. aluminum
4. When the beam is above the threshold for neutron production, it also produces:
 - a. muons
 - b. ozone
 - c. residual radioactivity
5. Which two interactions essentially cause the electromagnetic cascade?

6. Estimate the gamma dose rate from a thick target *in rad/hr*, one meter from the target in the sideward direction (90°) if the beam is 1 GeV at 100 uA (100 kW).
7. In terms of intensity, which type of radiation predominates inside the beam enclosure during operations? _____
8. Most neutron radiation is produced by nuclear reactions initiated by : _____ (what type of "particle")
9. Fill in the chart...

beam energy	radiation(s) produced	e- γ shower ?	activation?
500 keV			
1 MeV			
10 MeV			
45 MeV			
800 MeV			

10. Refer to the chart on page 27. Of the nuclides shown under "produced nuclide", which of these isotopes will occur in the greatest amounts in the air inside the enclosure? The production of the material is a function of: The abundance of the parent, the cross section for activation, and the half life of the produced nuclide (the shorter the half-life, the faster it builds up).

11. Is the following ALARA risk assessment approach valid? Why or why not? (use "Radiation Risks in Perspective")

Population size: 1 million people.

Each person receives 5 mrem -- cumulative dose is then 5000 person-rem.

If the cancer risk factor is assumed to be $4\text{E-}4$ per rem, there should be 2 excess cancer fatalities due to the exposure ($5000 \times 4\text{E-}4 = 2$).

12. How does ALARA compare to practices such as use of a hardhat? How is it similar, and different?

Worksheet for Assigned Radiation Monitor Unit 3 Self Study

1. In a gas filled detector, ions that are created by the interaction of radiation in the chamber are collected via _____.
2. In a detector operating properly in the ionization region, the gas amplification factor is:
 - a. $> 10^5$
 - b. 10
 - c. dependant on the specific detector
 - d. 1
3. A proportional detector generates a _____ for each ionizing particle detected.
4. Based on table 1 on page 37, which type of radiation will result in the largest pulse height output from a proportional detector (all the ion pairs from a given particle cause one pulse).

5. The type of detector most affected by dead time is _____.
6. In a scintillation detector, incident radiation is converted to _____ in the detector crystal.
7. When using a boron-loaded neutron detector, such as a BF_3 proportional detector, slow neutrons are captured by the boron atom, resulting in the immediate emission of _____.
8. If using a GM survey meter in an area where a pulsed radiation field may be present, a potential problem is:
 - a. exceeding the maximum range of the instrument
 - b. the detector may respond to the pulse repetition rate rather than exposure rate
 - c. response to the high RF field
 - d. insensitivity to the neutron field, which is always the main concern around pulsed sources
9. A serious potential for interference with the operation of portable instruments is caused by:
 - a. Fluorescent lighting
 - b. Dehumidifiers
 - c. Energized Magnets
 - d. Cryogenic systems

Worksheet for Assigned Radiation Monitor Unit 4 and 5 Self Study

1. The general area dose rates in the tunnel AFTER beam operation are best described as:
 - a low to moderate (~ 1-100 mrem/hr)
 - b high, but not lethal (~ 5 rem/hr)
 - c variable, up to lethal range (~ 1 - 10⁶ rem/hr)

2. The main type of radiation of concern (what we normally survey for) in the enclosure after shutdown is:
 - a beta
 - b gamma
 - c alpha

3. The trigger point for posting a Radiologically Controlled Area (RCA) is 0.05 mrem/hr (50 micro-rem/hr). This value is based on:
 - a a dose rate that's easy to detect with most instruments
 - b an arbitrary level which is administrative in nature
 - c the dose limit for a non-monitored individual (100 mrem/yr)

4. Airborne radioactivity induced in the beam enclosure has what properties?
 - a primarily consists of tritium
 - b primarily gaseous and short lived
 - c primarily particulates with moderate half-lives

5. A complication for doing work involving the breach of a beam dump cooling water system is that the water is contaminated with nuclides such as Be-7 and H-3. Why is this a 'complication' (as compared to other nuclides) ?

6. Describe the postings necessary for the following condition found on a beamline flange:

Contact dose rate 350 mR/hr, WB dose rate 60 mR/hr.
 - a. High Radiation Area
 - b. Radiation Area & Hot Spot
 - c. High Radiation Area & Hot Spot

7. When surveying hall B to go to Restricted Access, what is the trigger level of concern for posting?
- 5 mR/hr
 - 100 mR/hr
 - 50 uR/hr
 - 20 uR/hr
8. The rapid access system used in hall B is designed to:
- Warn people of the presence of a high radiation area
 - Allow access without a survey, but verifying that general area dose rates are low
 - Allow emergency access only
 - Make sure there is no airborne radioactivity
9. How is the rapid access system in hall B different than the one in the injector ?
- The hall B system is more sensitive
 - There is no residual activity in the injector, so the beacon would indicate a potential for a “beam-on” situation.
 - The injector system is interlocked
10. The existence of a whole body dose rate > 1000 mR/hr in an accessible area causes:
- A DOE violation
 - The activation of a RWP which requires special access controls
 - An exclusion zone – no one is allowed to enter until the levels have dropped.
11. The Contamination Area is posted when beta-gamma contamination levels exceed:
- 5000 dpm/100 cm²
 - 10,000 dpm/100 cm²
 - 1000 dpm/100 cm²
 - the limits of detection of the equipment being used
12. Requirements for entry to a High Radiation Area include:
- RWP
 - Supplemental dosimetry
 - Protective clothing
 - A and B
13. ARMs may enter Radiation Areas under what circumstances:
- Never
 - Only with specific concurrence from Radcon
 - For short periods of time to complete radiation surveys
 - Only during emergencies
14. During an emergency, firefighters may encounter potential sources of contamination. What is the best way to ensure a firefighter has not become contaminated during his/her response?
- Have them leave their equipment here
 - Make sure they wash all exposed skin surfaces before leaving
 - Perform a frisk on them
 - Use a Bicron microrem to survey their equipment